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UNITED STATES DEPARTMENT OF AGRICULTURE
Washington, D. C. 20250

REPORT AND RECOMMENDATIONS
of the
PLANT SCIENCE AND ENTOMOLOGY RESEARCH ADVISORY COMMITTEE
Developed at its Meeting
March 1-5, 1965
Silver Spring and Beltsville, Maryland

PLANT SCIENCE AND ENTOMOLOGY RESEARCH ADVISORY COMMITTEE

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PREFACE

The Committee reviewed annual Progress Reports and other working materials relating to broad aspects of the research programs of the Crops and Entomology Research Divisions of the Agricultural Research Service. Research leaders briefly described the Divisions' programs and defined some important accomplishments and needs. Some scientists at the Agricultural Research Center, Beltsville, Maryland, described field and laboratory research and gave several demonstrations of procedures, achievements, facilities, and problems yet to be solved.

Included in statements developed by the Committee at the end of the meeting was the following:

The Committee was most favorably impressed with the direction of effort, the scope of research, and the balanced viewpoints of the Crops and Entomology Research Divisions. The Committee was generally impressed by the staff who discussed the Department research. They are soundly motivated and have a full grasp of their subject matter and the type of knowledge required. For example, the strongly developed program in insect control showed every evidence of careful planning and breadth of understanding of what chemicals could be expected to contribute to a balanced program employing all possible methods of insect suppression. The more recently developed program for studying mechanism of action of herbicides and persistence in the environment has moved forward with dispatch and achieved an amazing amount of new knowledge in the few months of its operation. We interpret these observations as good evidence of long-range planning and sound administration, which was evident at many points.

Dr. N. C. Brady, USDA Director of Science and Education, is Chairman of the Committee; Dr. H. A. Rodenhiser, Deputy Administrator for Farm Research, Agricultural Research Service, is Vice-Chairman.

COMMENTS AND RECOMMENDATIONS

GENERAL

The Committee was impressed by the good collaboration between USDA, State, and industrial research organizations. The Committee believes that the fundamental contributions which Department scientists can make should not be jeopardized by an excessive amount of routine work. In many States, USDA and local specialists work together in State or university supported laboratories. We commend this procedure as opposed to the Federal government setting up small stations in many different locations.

Over a period of years we would urge consolidation of small branch stations into a few regional centers working collaboratively with an appropriate Land Grant College or State Experiment Station in the region. In this way, USDA establishments will be staffed to study broad aspects of agricultural research and will thereby be in a position to make recommendations regarding new approaches and principles of crop production.

The Committee is pleased by the increased amount of USDA funds that is being used in extramural programs -- i.e., for research under grants or contracts with universities, colleges, and other institutions. However, the sharply increased support of agricultural research workers from non-agricultural sources threatens to dilute or divert the energies of these workers in their assignment of being of service to agriculture. Therefore, we recommend that adequate funds be made available through the Department of Agriculture for providing grants and contracts for agricultural research.

The grant and contract programs should be productive and mutually reciprocating. Ideas can be drawn from a larger pool of personnel, contributions in research can be achieved, and much-needed support will be afforded in training new personnel for scientific positions. The greatly expanded needs of research agencies such as USDA for well-trained scientists has created serious shortages in our supply of available personnel. Financial support in the form of grants or contracts under a continuing program should enable universities and colleges to encourage more young men to become interested in scientific areas oriented to the life sciences and make it possible for them to pursue training in these areas.

Future research achievements of the Department are dependent upon maintaining a highly creative, strongly motivated staff. Concurrent with an expanded program for grants and contracts, every effort should be made to upgrade the more promising young professionals in the Department by encouraging them to enter into graduate training. Programs of in-service training and leave for study should be developed for all Department scientists. The rapid progress of science and introduction of new techniques of research can be fatal to individual scientists unless special effort is taken to keep abreast of these changes.

Possible ways of supplementing the present training program are a system for regular sabbatical type leaves, or short-term exchanges of scientific personnel with non-federal agencies.

The Committee is concerned with the present limitation on number of positions in the GS-14 grade and higher. Top-notch scientists will be required to give the desired leadership in a number of existing or newly created areas of work, and these positions must be made competitively attractive.

The efforts being made by the Director of Science and Education to coordinate the research work within the Department of Agriculture, between the Department and other departments of the government, and in the federally supported projects in the States are highly commendable. The development of a system of retrieval of data on expenditures, manpower allocations, and subject matter areas by crops and problems is essential in such a diverse operation.

Choice of research objectives should be made as much a responsibility of administrators and staff as possible. They are in the best position to know what can be done with the background knowledge and resources available at any given time. Certainly, local demands and political consideration should not take precedence over sound administration of research. The Department should have freedom to shift personnel and close out entire laboratories where urgent needs in other research areas must be met in promoting the general welfare of agriculture. The Executive and Legislative Branches of the Government should seek to adopt policies which will respect this basic policy and protect it as fully as possible. By so doing, better use will be made of research dollars by using available manpower most effectively.

PESTICIDES AND GROWTH REGULATORS

The program in pest control is comprehensive and well balanced. It is of such quality and distribution of effort that there is every reason to expect the best possible progress in developing the use of chemicals for pest control and in integrating such use with other measures so as to provide maximum production of food and fiber with minimum hazard to beneficial forms of life and the environment. Significant progress has been made in the development of biological and other non-chemical methods for the control of pests. Research in this area should be encouraged and further progress can be expected for the future. However, the need for pesticides either alone, or in combination with biological control methods will continue for the foreseeable future. Research support on pesticidal chemicals should not be diminished but rather should be extended in efforts to develop economically effective and safe pesticides for the many changing pest problems affecting the nation's agriculture and welfare.

There is a continuing need for research relating to the problem of pesticide residues in agricultural products. The Department is to be commended for its contributions to pesticide residue research in support of the development of insecticidal uses and recommendations. However, the Committee suggests that research on the occurrence and nature of residues of herbicides, nematocides, fungicides, and plant growth regulators in relation to actual use conditions should be increased. In developing this program, maximum use should be made of data available from all other sources.

We believe that the method sensitivity required to establish "no residue" registrations should be based on "pharmacologically insignificant" levels, rather than on the sensitivity of the analytical method available. We realize that the Committee on Pesticide Residues of the National Academy of Sciences - National Research Council, composed of representatives from industry, universities, and State agencies, is investigating this problem. It is urged that appropriate officials in agricultural and health agencies take such action as is necessary to resolve this serious problem.

The Committee was impressed with the research now in progress on the use of herbicides for weed control. The excellent current work on metabolism and mode of action of herbicides should be continued. Expansion should be considered to develop basic information on the mechanism of action and differential behavior of herbicides in and on plants and soils. Such information will provide data needed to develop new principles and measures for the use of chemicals in controlling many weed and brush species which are now serious problems. Due to variation in soil and climatic conditions, coordinated studies are suggested for a number of locations. This will increase the practical significance of the data obtained.

Progress made in the control of several plant diseases through the use of chemicals is noted. We believe that this effort should be increased. Attention should be given to setting up a group of scientists to conduct basic research on the mechanism of action of fungicides and to develop new principles and approaches to their use for plant disease control. Metabolism and mode of action studies similar to those described above for herbicides should be included.

The Committee notes that only 4.5 professional man-years are devoted to research on nematocides and that projected change calls for only one additional man-year. Increasing amounts of information are becoming available indicating that nematodes are of major importance as agricultural pests. They not only cause direct damage but are implicated with disease complexes involving fungi, bacteria, and viruses. An increased effort in basic research in the control of nematodes by chemicals is recommended.

It was noted that no increased effort is projected for basic research on the problem of insect resistance to chemicals. The resistance problem continues as one of the urgent problems in the pesticide field. Significant contributions to a solution of this problem would greatly assist in the control of many insects.

The ingenious use of a pesticide in resolving the problem of developing a procedure for producing hybrid barley was noted with admiration. This points up an aspect of the tremendous new science of designing and devising biologically active molecules for pest control and plant regulation which usually escapes the attention of both the public and scientists in other fields. Materials identified in this work become tools in the hands of scientists to broaden their understanding of basic aspects of plant chemistry and to diversify their precise control over living processes.

Such research as this on barley could not be anticipated, but comes from the ingenuity of scientists who have experimental tools in the form of molecules available in the scientific storehouse of knowledge. We urge agricultural scientists to note this fact and employ these substances as research tools in seeking novel effects with plants, animals, and pests.

PLANT INTRODUCTION AND EVALUATION

The Committee recognizes the contributions made to crop improvement through the cooperative program of plant introduction, evaluation, and maintenance of germ plasm. Needs of agriculture for accelerated research on natural sources of resistance to insect pests and diseases justify expansion both in plant exploration and preliminary evaluation of collected materials. Existing regional and inter-regional cooperative programs between the State stations and the Department would be strengthened by the utilization of automatic data processing techniques in evaluating plant introductions and in quickly retrieving data that provide plant breeders with information on sources of desired genetic characters.

The problems faced in getting a promising new crop over the stage at which it is emerging as a commercial crop are of concern to the Committee. Insufficient research is being devoted to the agronomic development of potentially promising crops. It is noted that in this area there has been a reduction of 3.1 professional man-years from a total of only 9.9. This manpower might well have been redirected to promising new crops which are in need of intense agronomic research. Potential crops other than oil-seeds should receive emphasis. Crops from which insect controlling substances can be produced with low toxicity to man and animals deserve special consideration.

PLANT BREEDING AND GENETICS

The relatively large program of plant improvement with more than a hundred species fully justifies the present effort in this field.

There is critical need for research directed toward isolating and elucidating morphological, physiological, pathological, biochemical, and other characters and phenomena in plants which have a bearing on immunity, resistance, and/or susceptibility to pathogens and insects. There is equal need for expanded basic genetic research on both the crop host and plant pathogens, insects, and nematodes, including the complementary biochemical and physiological studies of gene interrelationships.

We commend the Department for providing funds for the establishment of a non-commodity oriented research staff to investigate in depth the nature of resistance of plants to pathogens, insects, and nematodes. Significant breakthroughs are anticipated from this research. Attention must be given to providing continuing support for this fundamental research both in manpower and dollars, because results are basic to the needed development of disease- and insect-resistant crop varieties.

Direction of effort in plant breeding programs should be towards the establishment of teams consisting of plant pathologists, entomologists, nematologists, physiologists, and geneticists so that crop varieties of top quality can be developed having multiple resistance to disease-producing organisms, insects, and nematodes.

CROP QUALITY

A need for greater emphasis on methods of determining crop quality is apparent. Changing and more specialized market requirements make many present relatively crude and subjective methods of evaluating quality inadequate. A stage has been reached where breeding programs and other research efforts are sophisticated enough to demand that the components of quality be objectively and quantitatively evaluated. We recommend expansion of research to identify important quality components and to develop objective means by which they can be measured.

CROP CULTURE AND MANAGEMENT

The importance of research in culture and management of plants is recognized. The increasing use of new hybrids and varieties and increasing use of chemicals must be accompanied by research to enable growers to use the optimum combination of chemical, cultural, and management practices consistent with quality requirements as dictated by crop usage. Otherwise, outmoded production practices may limit returns to the grower. The solutions to some of these problems have regional or national application. Hence, research by the Department is encouraged. At the same time, it should avoid research of primarily local application, which should properly be done by the State Experiment Stations.

PERENNIAL GRASSES AND LEGUMES

The recommendations made by the Committee with respect to all phases of plant science and entomology research are underscored for perennial grasses and legumes. The reasons for this are as follows:

1. Although perennial grasses and legumes are of great importance from economic, soil conserving, and aesthetic standpoints in every State, research support has not kept pace with that in most other fields.
2. Many of the problems are of a national or regional nature. For example, seed is often produced at great distances from the area of varietal development and use -- hence State research efforts often are inadequate to provide the coordinated approach required in reaching solutions of the complex problems involved.
3. The number of species involved, as well as the relatively longer time cycles for breeding and evaluation, require more man-years of research to attain the rate of success possible with annual crops such as corn, wheat, and cotton.

4. The effectiveness of action programs for establishment and maintenance of the desired grass cover, as carried out by Federal agencies such as Soil Conservation Service, Agricultural Stabilization and Conservation Service, Forest Service, National Park Service, Bureau of Public Roads, Bureau of Land Management, and the Department of Defense is being hampered by lack of adequate research information and proven plant materials.

BIOLOGICAL AND CULTURAL CONTROL OF WEEDS

Excellent progress has been made toward reducing the use of pesticides by improving traditional cultural practices and by developing and projecting biological controls such as the use of insects, plant diseases, and animals to destroy weeds. The Committee recommends continual development of the program by in-depth studies needed to understand more fully the life cycles of the weeds and their predators. Chemical and physiological phenomena governing germination of seed, growth and maturation of the plant, and competitive effects of plants and predators must be fully understood. Exudates or emanations from plant roots and plant residues which might influence plant growth or seed germination should be studied. It is suggested that research be done on the total ecology surrounding the economic plant, the effect of population pressures on weeds and crops, and that the program be continued at a level no less than that of fiscal year 1965.

BIOLOGICAL AND CULTURAL CONTROL OF PLANT DISEASES

The control of soil-borne plant pathogens has been extremely difficult to achieve except in isolated instances where resistant strains have been found. Studies suggesting that soil-borne plant pathogens may be biologically controlled are of enormous significance. Studies along these lines need to be expanded as rapidly as possible. These studies should emphasize the basic biological phenomena involved. It is important to learn whether toxic substances, competition from other organisms or other factors are involved. The development of basic principles is more important at this time than applied investigations, because such studies should reveal what conditions need to be created in order to suppress the population of undesirable organisms in soils.

The Committee took note of the effect of micro-organisms on the quality and safety of food products. A careful survey should be made of the plant disease agents occurring on plants that may have an ability to deteriorate or enhance the nutritional value of the commodity or to produce mycotoxins or other products that affect animal life. Investigations should be made on the sources of inoculum, the effect of environment and cultural methods used in crop production on establishment of the parasite and methods of detecting the causative agents, such as Aspergillus flavus, on various plants. The proposed research implies that it is necessary to intensify research on taxonomy of causal agents and their epidemiology, so the Crops Research Division is to be congratulated for seeking improved programs in these supporting areas. It is recommended that careful consideration be given to initiating such a survey and research on organisms that produce biologically active molecules.

The Department is commended for substantially increasing personnel assigned to research on control of plant diseases by means other than chemical and for redirecting research to such currently important problems as corn stunt and maize dwarf diseases. It is suggested that every effort should be made to give greater emphasis to biological control where such methods may be applicable.

Consideration should be given to developing an isolated laboratory for plant disease studies. It is evident that new plant virus disease problems are occasionally arising in the U.S.A. through entry from other countries of the world. Examples are the previously mentioned maize dwarf mosaic and corn stunt. Examples of exotic diseases presenting a future hazard are Verticillium wilt of alfalfa which is serious in Europe and now present in Canada, and a strain of blue mold in Europe which attacks the mature tobacco plant. The Committee suggests that the possibility and potential usefulness of a suitable isolated area be explored.

BIOLOGICAL AND CULTURAL CONTROL OF NEMATODES

The control of nematodes by means of resistant varieties of plants, cultural practices, crop rotation, and other non-chemical methods has been encouraging. Parasites are known that may be effective in reducing populations of parasitic nematodes. While these kinds of techniques are not applicable in all circumstances, it is important that the basic principles involved be investigated in order to extend their usefulness. Basic studies are needed on the relationships between nematode populations and the physical, biological, and chemical properties of soils and the interaction with host plants. Recently developed techniques for cultivating nematodes under aseptic conditions and on known media should be particularly useful for physiological and biochemical investigations.

The proposed staff additions and the proposed shift in emphasis from cultural studies to biological and physiological studies are particularly desirable.

PLANT GROWTH AND DEVELOPMENT

The work of the Plant Physiology Pioneering Research Group on the discovery of phytochrome and its role in controlling plant growth and development has been outstanding.

The Committee believes that research on photoperiodism in plants should be continued. A great many problems still remain to be solved, especially on the nature of phytochrome and its biochemical function. There still remains, in addition, a very large amount of research to be carried out on the effect of radiant energy on plant growth and development. One possible area of research might be on the photosynthetic efficiency of different plants. Such information would be useful to plant breeders engaged in improving crop efficiency. We do not know enough about the growth responses of plants to changes in photoperiod. Many of our crop plants and horticultural plants have been introduced from different parts of the world, and their reactions to photoperiod need to be evaluated.

STRESS PHYSIOLOGY OF PLANTS

Plant hardiness and drought problems require increased coordination among plant physiologists, biochemists, morphologists, geneticists, plant breeders, climatologists, and soil scientists. To be most effective the work should be concentrated at a few key locations with coordination at the national level.

The problems associated with salt tolerance of plants are bound to increase as irrigation practices expand. Basic physiological and biochemical studies should be carried out to gain insight into the nature of the influences of salt accumulations in soils on plant growth and development. New plant materials should be introduced and evaluated for potential usefulness under saline conditions.

AIR AND WATER POLLUTION

Research dealing with the effects of air and water pollution on plant and animal growth and health requires immediate attention. The Committee conceives that those problems dealing with the production of food are the responsibility of organized agricultural research. This should be a major effort done in cooperation with State and Federal agencies now engaged in such research. The agencies concerned should be identified and their areas of interest considered when planning work in these fields.

Agriculture has a major stake in pollution studies, and the Committee recommends that planning be accelerated on the size of the effort and the manner of organization necessary for solving problems dealing with both air and water pollution.

NEW METHODS FOR APPRAISING GROWTH AND HEALTH OF VEGETATIVE COVER

There is substantial evidence that remote sensing devices can be employed to measure the distribution and character of vegetative covers. Infra-red aerial photography and other devices may make it possible to detect disease infestation, decline of trees and crops due to abnormal soil conditions and possible devastation by insects that destroy or defoliate plants. These studies are invaluable in surveying crops expeditiously for trouble spots requiring corrective treatment and in making crop estimates. Such research can be most useful to other activities of the Federal government such as remote exploration of other planets by satellite survey. The Committee recommends that sufficient funds be made available to complete the appraisal of this new technique in crop production.

NATIONAL ARBORETUM

The Committee notes the substantial progress and projected plans of the National Arboretum. We heartily endorse this development and urge its adequate support, both as a means of developing appreciation of the public for aesthetic uses of plants and for research on ornamentals. We visualize the Arboretum will prove its worth as a center for testing of new plant introductions as potential ornamentals.

INSECT IDENTIFICATION AND CLASSIFICATION

It is recommended that high priority be given to research support for work in insect identification and classification. The small staff of key scientists in the USDA responsible for the identification of insect and mite specimens is currently seriously overburdened and faced with a 20 man-year backlog of unidentified specimens. Entomologists from various institutions and agencies throughout the Nation are dependent upon identification of this material for the development of their research and regulatory programs. These key scientists should be given sufficient support so that they will no longer be unduly burdened with preparatory work and routine identification. Such support would enable them to perform the necessary identification and yet devote a fair portion of their talents to more creative and challenging duties such as the development of keys and monographs so urgently needed. It should be stressed that the tremendous reservoir of data in the hands of these taxonomists is relatively useless to science unless it is made available in published form.

There is need for initiation of research that will provide experimental evidence for distinguishing differences between species of insects that cannot be recognized on anatomical characters. Techniques are available for separating species on data resulting from basic studies on insect biology and ecology, genetics and cytology, electrophoresis and chromatography, and micromorphology. Many of these data can be obtained only from research with living samples of insect populations. It is recommended that facilities be made available for this research, including adequate insectaries, greenhouses, and specialized laboratories as required.

The Committee recognizes the need for specialists adequately trained in the field of systematic entomology. It is recommended that promising students be encouraged to choose subjects for graduate study that will fit them for this field and that funds be made available to the USDA for support of graduate research by means of grants to universities.

BASIC INSECT BIOLOGY, PHYSIOLOGY, AND PATHOLOGY

Personnel in the USDA should be commended for their foresight in establishing the pioneering research laboratories, examples of which are the Pioneering Insect Physiology Laboratory and the Pioneering Insect Pathology Laboratory. Important discoveries have already been made in biology, physiology, and pathology in these and other laboratories in the Entomology Research Division. Research in these areas is basic to progress in the use of sterile males, micro-organisms, attractants, radiant and sonic energy or other new concepts in insect control. Finding a satisfactory artificial diet for rearing a major insect pest, or an acceptable tissue culture for an entomophagous micro-organism, may determine the success or failure of a potentially good control procedure. Basic physiology work on feeding stimulants may lead to direct progress in selection for resistant varieties in plants, or in development of attractants or antagonists to insects.

The Committee is pleased to note that there will be a substantial increase in staff for 1965 in the areas of basic insect biology, physiology, and pathology. This increase would appear to be necessary in order to keep pace with the growth in the area of biological and specific chemical methods of insect control. Further increases in staff and facilities for work in basic physiology, nutrition, and pathology are suggested in order that new ideas in insect control may be more completely explored without delays attributable to lack of fundamental knowledge. When funds become available for expansion into new areas, it is suggested that research in genetics be initiated for detection of markers useful in biological, ecological, or other basic investigations in applied ecology.

BIOLOGICAL AND SPECIFIC CHEMICAL METHODS OF INSECT CONTROL

The Entomology Research Division is commended for the excellent program of basic research proposed for the Biological Control of Insects Research Laboratory to be developed at Columbia, Missouri. It is urged that every possible effort be made to complete the buildings and recruit the staff of this facility at the earliest possible date.

The Committee is pleased to note that new funds in fiscal year 1965 for additional personnel and contracts and grants permit material strengthening of research on controlling insects by methods other than use of conventional insecticides.

Research on insect attractants and repellents needs to be expanded. The value of chemical attractants for the Mediterranean and Oriental fruitflies has been amply demonstrated in early detection and delimitation of infestations in the United States. A number of insects have now been found to possess attractancy for the opposite sex and research on recovery, analysis, possible synthesis and usefulness of these compounds is promising. Attractants and attractive nutrients for beneficial insects should be investigated. Attractancy of light and sound to some species of insects has been demonstrated. Utilization of these principles could reduce materially our dependence on chemical pesticides. However, these are not broad spectrum practices, but usually specific and will require basic studies with individual insect species.

Studies of insect sterility methods should be expanded. Research on safe chemosterilants that may be used against natural insect populations without endangering man, animals or birds is urgently needed.

The chemistry of the insect juvenile hormone and other hormones that control the development of insects should be elucidated and the potentialities of these agents or related synthetic compounds for insect control should be explored.

Additional research and exploration are needed to discover beneficial species of pathogens, insects, and mites in foreign countries which may be introduced into the United States.

Research should be expanded on the utilization of periodic mass release of beneficial organisms for the control of pest species. Possibilities in this area may be greatly increased as new knowledge of insect nutrition and technical improvements reduce the cost of mass production programs.

Basic studies on integrated control of insects should be intensified. Present practices and recommendations attempt to integrate various methods of insect control, but information on the effects of these practices on the components of the ecosystem are needed on which to base recommendations.

The Committee feels that the promising new ideas mentioned above should be pursued as thoroughly as is feasible in view of available funds and manpower and every possible effort should be made to expand the program.

INSECT VECTORS OF PLANT AND ANIMAL DISEASES

Pathogenic viruses cause losses in major crops and animals amounting to millions of dollars annually. Some of these viruses are transmitted by insects, mites, or other arthropods in an association that is complex. Adequate knowledge of distribution, identity, and transmission must be available before efficient means of control can be devised.

The Committee notes that there will be an actual decrease in effort devoted to this important area of research in 1965. It is believed that the effort in this area should be increased. The Committee suggests that work on insect vectors of animal diseases could be best accomplished through a cooperative effort between the entomologists and animal and plant pathologists and virologists.

BEEES AND OTHER POLLINATING INSECTS

Bee research needs a rejuvenation along lines of basic research in genetics, physiology, pathology, and nutrition. To this end, the Committee recommends the staffing of the Tucson bee research laboratory as soon as possible. Work on developing inbred lines should be expanded. Studies should be initiated to develop methods for maintaining and preserving genetic stocks that can be used in national and international cooperative bee improvement programs. To this end, careful consideration should be given to establishing a genetic stock center to which breeders could turn for available germ plasm.

